MNE COMPETENCE-CREATING SUBSIDIARY MANDATES

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The determinants of R&D intensity differ between subsidiaries in a multinational enterprise (MNE). Previous literature suggests that whether a subsidiary achieves a competence-creating output mandate depends on the qualities of its location. R&D strategies in competence-creating subsidiaries are supply-driven while those in purely competence-exploiting subsidiaries are demand-driven. Using data on U.K. subsidiaries of non-U.K. MNEs, we find that the level of subsidiary R&D depends on MNE group-level and subsidiary-level characteristics as well as locational factors. The R&D of mandated subsidiaries rises with acquisition, but for non-mandated subsidiaries R&D falls upon acquisition. MNEs that grow through acquisition have more inter-subsidiary R&D diversity. Copyright © 2005 John Wiley & Sons, Ltd.

Historically, multinational enterprises (MNEs) located R&D in their subsidiaries abroad mainly for the purposes of the adaptation of products developed in their home countries to local tastes or customer needs, and the adaptation of processes to local resource availabilities and production conditions. Subsidiaries depended on the competence of their parent companies, and so their role was essentially just competence exploiting, or in the terminology of Kuemmerle (1999) their local R&D was ‘home-base exploiting.’ In recent years instead, linked to the closer integration of subsidiaries into international networks within the MNE, some subsidiary R&D has gained a more creative role, to generate new technology in accordance with the comparative advantage in innovation of the country in which the subsidiary is located (Cantwell, 1989, 1995; Papanastassiou and Pearce, 1997; Cantwell and Janne, 1999; Pearce, 1999; Zander, 1999a). This transformation has led to an increase in the level of R&D undertaken in at least those subsidiaries that have acquired this kind of competence-creating mandate, and in these subsidiaries there has been a change in the motives for and thus in the drivers of local R&D.

The shift toward internationally integrated strategies within MNEs is partly grounded on a ‘life cycle’ effect within what have become mature MNEs. Longer-established MNEs have now created a sufficient international spread in their operations that they have the facility to establish an internal network of specialized subsidiaries. Selected subsidiaries in such a network may evolve a specific regional or global contribution to the MNE beyond the concerns of their own most immediate market (Birkinshaw, Hood, and Jonsson, 1998; Cantwell and Piscitello, 1999). Thus, subsidiaries that began as local market-oriented (import-substituting) units are gradually transformed into more export-oriented and internationally

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integrated operations. While some of the subsidiaries within such a network may have essentially just a competence-exploiting or an ‘assembly’ role, others take on a more technologically creative function and the level and complexity of their R&D rise accordingly (Cantwell, 1987). The distinction between purely competence-exploiting and competence-creating activities is analogous to the distinction between exploitation and exploration in organizational learning theory (March, 1991; Danneels, 2002). Competitively stronger MNEs are more likely to locate R&D abroad, and to evolve toward a greater variance in the levels of R&D across their subsidiaries, with R&D becoming concentrated in sites where local conditions are most conducive to technology creation (Cantwell and Kosmopoulou, 2002).

While March (1991) focused upon the role of diversity across individuals within an organization as a means of facilitating exploration, the same principle applies with respect to the emergence of a greater diversity across subsidiary units within the organization of the MNE. The evolution of some subsidiaries towards a competence-creating role within the MNE implies a greater degree of organizational diversity at a corporate group level. This might be understood as a desirable adjustment by MNEs since it has the effect of promoting a better balance between exploitation and exploration in learning in the organization as a whole. In other words the benefits come not just from the direct contribution to their MNE group of competence-creating subsidiaries considered individually, but also because the organization as a whole gains in its collective capacity for exploration (with long-run performance advantages) owing to the greater degree of cross-subsidiary diversity and experimentation. Of course, the benefits from increased exploration in the learning of MNEs are subject to the costs of managing a more complex international network.

In this paper our central research question is how the Marchian distinction between exploration and exploitation in organizational learning (in our case, within the MNE) affects the level of R&D in each type of subsidiary (those that are competence-creating, vs. those that are purely competence-exploiting). This dichotomy of subsidiary types is not new, and is closely related to earlier such subsidiary typologies. Table 1 summarizes the relationship of our distinction between competence-creating and competence-exploiting subsidiaries with the other related typologies that can be found in the international corporate strategy literature. However, most of these previous conceptual schemes have focused on the location as the source of differentiation between subsidiaries, that is, on the potential for innovation in each subsidiary’s own external environment. Thus the first contribution of our paper is to allow (in the R&D context) for the fact that subsidiary evolution may to some extent gain a logic of its own, such that managerial initiative and discretion affect how well a subsidiary takes advantage of its location.

Most of the earlier discussions focused upon the emergence of more complex organizational strategies required in more internationally integrated MNEs at a group level (Doz, 1986; Hedlund, 1986; Porter, 1986; Bartlett and Ghoshal, 1989), or the growing significance of asset-seeking motives at an MNE group level, as opposed to the better-established market-seeking and resource-seeking

Table 1. Alternative views of the competence-creating vs. competence-exploiting subsidiary mandate decision in the contemporary international business literature

<table>
<thead>
<tr>
<th>Competence-creating subsidiary mandate</th>
<th>Competence-exploiting subsidiary mandate</th>
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<tbody>
<tr>
<td>Research-related production (Cantwell 1987)</td>
<td>Assembly-type production</td>
</tr>
<tr>
<td>Strategic asset-seeking investment (Dunning 1995, 1996)</td>
<td>Market-serving investment</td>
</tr>
<tr>
<td>Home-base augmenting investment (Kuemmerle 1999)</td>
<td>Home-base exploiting investment</td>
</tr>
<tr>
<td>Higher-order contributor to organizational heterarchy (Hedlund 1986)</td>
<td>Lower-order contributor to organizational hierarchy</td>
</tr>
<tr>
<td>Center of excellence subsidiary mandate (Birkinshaw, 1998; Holm and Pedersen, 2000; Simões and Nevado, 2000; Frost, Birkinshaw, and Ensign, 2002)</td>
<td>Location in a site that is not a major center of excellence or a key hub</td>
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activities (Dunning, 1995, 1996). Against this backdrop, Pearce (1999) and Kuemmerle (1999) developed a typology for subsidiary-level R&D in which the drivers of R&D diverge between subsidiary types, but the role of each subsidiary is governed essentially by the characteristics of the location in which it is sited. Internationally integrated strategies at the MNE group level led to a search of locations for their supply-side (innovative and skill-related) potential, in addition to their conventional demand-side potential (as markets). Hence, R&D strategies in competence-creating subsidiaries are supply-driven, while those in purely competence-exploiting subsidiaries are demand-driven.

A more recent strand of literature has instead begun to examine strategy at the level of the subsidiary rather than the level of the corporate group as a whole. It has emphasized the analysis of subsidiary-level organizational strategies when subsidiaries are based in, and can themselves become for their corporate group, foreign centers of excellence (Birkinshaw, 1998; Taggart, 1998; Andersson and Forsgren, 2000; Ensign, Birkinshaw, and Frost, 2000; Holm and Pedersen, 2000; Simões and Nevado, 2000; Frost, Birkinshaw, and Ensign 2002). So following in the spirit of this newer literature, we allow here that the drivers of subsidiary R&D depend on subsidiary-level determinants as well as MNE group-level and location-specific influences.

The second contribution of our paper is that the earlier literature has examined the qualitative difference in the types of R&D conducted in different types of subsidiary (Pearce, 1999; Kuemmerle, 1999), while here we assess the implications of these differences for the quantitative level of subsidiary R&D. Building on the insights of March (1991), the knowledge generation associated with R&D is a bi-dimensional and not a uni-dimensional process. R&D may be high (or low) in both competence-creating and competence-exploiting subsidiaries, but for different reasons. Exploration activities tend to be costly, while exploitation activities are less expensive but tend to require a more extensive and continuous succession of development efforts.

The third contribution of this paper is that the previous literature on subsidiary R&D typology has implicitly focused on internal MNE growth and restructuring in response to external environmental stimuli (at the level of subsidiary locations, as mentioned already). Here, instead, we also pay attention to the effect of the acquisition strategies of MNEs on the divergence in the quantitative determinants of R&D in each type of subsidiary. Thus, it matters not only whether a subsidiary has evolved toward a competence-creating status or remains purely competence-exploiting, but also whether that subsidiary has been acquired by its current MNE group. This is a vital issue, since survey evidence has often suggested that most foreign-located R&D in MNEs is the result of acquisitions.

In this paper we follow in the tradition of supposing that some subsidiaries evolve toward the attainment of a competence-creating mandate (while others do not), to examine empirically the factors that determine the likelihood of subsidiaries acquiring a competence-creating mandate. This competence-creating mandate is defined by the output responsibilities of the subsidiary, and so the mandate is measured independently of the R&D function. We then check whether the level of R&D tends to be higher on average in competence-creating subsidiaries, as might be anticipated, although we can also expect that the range of R&D levels found in each type of subsidiary will overlap extensively. Beyond this, and more substantively, we examine whether the two types of subsidiary have some common underlying process of determination of their R&D level, or whether instead their R&D levels are governed by two distinct processes. In the latter case, in particular, we are especially interested in any effects that run in directly opposite directions in the R&D process in the two kinds of subsidiaries.

THEORETICAL FRAMEWORK

The subsidiary mandates that we observe are the outcome of a process of subsidiary evolution. While this process is not the direct concern of this paper, linking our model to the prior evolutionary process is helpful, since the factors that influence this process are also those that regulate both the subsidiary mandate and the subsequent R&D behavior of each type of subsidiary. A useful organizing framework for subsidiary evolution is provided by Birkinshaw and Hood (1998), who identify local environmental factors, subsidiary choice, and headquarters assignment as the three key drivers of the subsidiary’s role (formally defined
by its charter or mandate), with dynamic feedback effects. Within this dynamic framework, subsidiaries can both advance and decline in terms of their roles within the firm. In a similar vein, Frost et al. (2002) propose that the three sets of influences on the ability of a subsidiary to develop a center of excellence for its group are the dynamism of the location, subsidiary-level autonomy and the degree of integration of competence-creating activities between the subsidiary and other parts of its group, and the extent of support from the parent company.

Subsidiaries with competence-creating mandates can arise either through parent-driven or subsidiary-driven processes (Birkinshaw and Hood, 1998). However, in each case the acquisition of a competence-creating mandate requires a gradual subsidiary-specific evolution. A subsidiary’s capacity to evolve to the point at which a competence-creating mandate becomes viable depends upon the ability of its own managers to develop and exercise a ‘voice’ in the wider corporate group. Beyond the earliest stages of subsidiary evolution continued development requires some combination of local initiative and head office support. Thus, parent-driven investment strategies respond to subsidiary lobbying, while subsidiary-driven charter extension relies on a subsidiary-level champion gaining support at head office (Birkinshaw and Hood, 1998).

In turn, the ability of a subsidiary’s managers to attain an effective voice within their corporate group depends upon the three sets of factors just mentioned. Namely, (i) the characteristics and development potential of the location in which the subsidiary is sited; (ii) the internal state of subsidiary-level capabilities and the scope for undertaking independent initiatives; and (iii) the strategic practices and origins of the parent group with respect to their potential to encourage network formation across parts of the group and at a local level with external partners.

R&D will tend to be higher in subsidiaries that acquire competence-creating mandates as opposed to those that do not, and the award of such a mandate is more likely when the subsidiary is located in a regional center of technological excellence, when it has built up a higher degree of subsidiary-level capabilities for independent initiatives, and when the parent group encourages network formation. However, our central argument here is not merely that more R&D is now likely to gravitate to subsidiaries with a competence-creating mandate once the MNE’s objective is to establish an internationally integrated network for innovation, in place of an independent collection of multi-domestic operations with diffused adaptation. Rather, we contend that this new kind of R&D undertaken in competence-creating subsidiaries will be differently motivated than the locally adaptive kind of R&D that still predominates in purely competence-exploiting subsidiaries, and so it is qualitatively distinct in its determinants. Our empirical approach aims to examine the nature of this qualitative difference in motivations in terms of the factors that influence investments in subsidiary-level R&D.

The framework of the relationships we are proposing is summarized in Table 2. In a suitably favorable combination of locational, subsidiary-level and MNE group-level conditions, subsidiaries will evolve to acquire competence-creating mandates (stage 1), and their local R&D will come to be driven mainly by the requirements of technological creativity (stage 2). A qualification here is that when subsidiaries are acquired, from the

<table>
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<tr>
<th>Process of subsidiary evolution</th>
<th>Stage 0</th>
<th>Stage 1</th>
<th>Stage 2</th>
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<tbody>
<tr>
<td>Locational, subsidiary-level and MNE group-level conditions</td>
<td>Highly favorable</td>
<td>Competence-exploiting mandate</td>
<td>Competence-creating mandate</td>
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<td></td>
<td>Less favorable</td>
<td>Competence-exploiting mandate</td>
<td>Competence-exploiting mandate</td>
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Table 2. The evolution of subsidiary mandates, and the varying determinants of localized R&D
perspective of the acquiring group they may even begin with competence-creating mandates (stage 0)—we address this issue in our discussion of MNE group-level determinants below. Conversely, in less favorable conditions subsidiaries retain purely competence-exploiting mandates (stage 1), and their local R&D continues to be driven mainly by the needs of technological adaptation (stage 2).

**HYPOTHESIS DEVELOPMENT**

**Locational determinants**

The first influence on the likelihood of a subsidiary gaining a competence-creating mandate is the characteristics of the location in which it is situated. In a region with a good local infrastructure, a science base and a more skilled workforce, subsidiaries are likelier to acquire competence-creating mandates on behalf of their corporate group, and, once they have such a mandate, to use it to be able to attract more of the mobile R&D facilities of their MNE (Cantwell and Iammarino, 2000; Cantwell and Piscitello, 2002). Owing to the complexity of technological learning, and the significance of maintaining face-to-face contacts, the accessing of technological resources tends to occur at a regional level within host countries (Jaffe, Trajtenberg, and Henderson, 1993; Almeida, 1996; Cantwell and Iammarino, 1998). Thus, subsidiaries with competence-creating mandates tap into the munificence of their specific location (Pearce, 1999; Andersson and Forsgren, 2000; Ensign et al., 2000; Håkanson and Nobel, 2000). Hence, we expect that better-quality locations will see a higher R&D intensity in mandated subsidiaries. Non-mandated subsidiaries, on the other hand, are simply trying to adapt products to local markets and resource conditions. We expect the supply side quality of the location to have no effect on the R&D intensity of such subsidiaries.

In the United Kingdom, government investment incentive programs provide an inverse measure of overall locational quality, since they are made available to firms locating in areas with a combination of low labor skills and high unemployment, poor infrastructure, and many other drawbacks (Mudambi, 1998). These government incentives are provided under Regional Selective Assistance (RSA) in areas known as Assisted Areas (either Development Areas or Intermediate Areas), and these incentives include capital subsidies, loans, tax allowances, training support, and R&D support. There is evidence that even lucrative investment incentives are insufficient to attract high-quality R&D investment by MNEs (Cantwell and Mudambi, 2000). Thus, locations designated as Assisted Areas have poorer qualities, while all other areas ineligible for such incentives enjoy higher locational qualities.

*Hypothesis 1a: Location in an area covered by government investment incentives lowers the probability of a subsidiary achieving a competence-creating mandate.*

*Hypothesis 1b: Location in an area covered by government investment incentives lowers the R&D intensity of subsidiaries with competence-creating mandates, but has no effect on the R&D intensity of subsidiaries without competence-creating mandates.*

Some locations offer high levels of local demand. The primary function of subsidiaries without competence-creating mandates is to serve the local market. Their role is predominantly demand-driven. Hence, the higher the level of local sales (demand) in a location, the more the incentive to undertake process improvements, as well as to differentiate output to bolster margins. Both these activities lead to increased R&D intensity in the adaptation of the firm’s output to local conditions. However, the primary function of subsidiaries with competence-creating mandates is to tap into the local knowledge and resource base to augment the MNE group’s overall strengths. This role is predominantly locally supply-driven. For such subsidiaries, higher or lower output (demand) in their location should not affect R&D intensity.

*Hypothesis 2: Higher local output (demand) leads to a higher R&D intensity in subsidiaries without competence-creating mandates. The level of local demand does not affect the R&D intensity of subsidiaries with competence-creating mandates.*

Some locations tend to experience more systematic fluctuations in demand, and so present a greater demand-side financial risk to the MNE. Reasoning as above suggests that substantial fluctuations
in demand in a location (associated with higher variance in a subsidiary’s rate of return) should reduce the commitment to undertake R&D activities in demand-driven subsidiaries with purely competence-exploiting mandates. However, such uncertainties over the state of local demand should have much less effect on the R&D activities of subsidiaries with competence-creating mandates, given again their supply-driven orientation.

Hypothesis 3: Greater variability in local demand leads to a lower R&D intensity in subsidiaries without competence-creating mandates. Such variability does not affect the R&D-intensity of subsidiaries with competence-creating mandates.

Subsidiary-level determinants

Apart from the locational environment in which it operates, a recent subsidiary-level literature has suggested that the greater the extent of subsidiary autonomy, the better the ability of the subsidiary to form favorable external network linkages with other companies and institutions in its own local environment (Birkinshaw et al., 1998; Andersson and Forsgren, 2000). In its turn, the greater the local embeddedness of the subsidiary, the higher the likelihood that it will acquire a competence-creating mandate. It has been shown that, compared to adaptive subsidiary R&D facilities, the creative subsidiary R&D establishments have adequate independence to have developed stronger external and internal network relationships that foster innovation (Nobel and Birkinshaw, 1998).

We should qualify this argument by noting that it is not strategic independence per se that is important, but the manner in which strategic independence is used by the subsidiary in the context of competence-creating mandates. If strategic independence becomes a substitute rather than a complement for close communication with the rest of the MNE, the subsidiary can drop ‘out of the loop’ and weaken its intra-firm position. Thus, although it is possible that at any point in time there may be subsidiaries that use their independence in pursuit of objectives that are tangential to those of the rest of the group (e.g., Mudambi and Navarra, 2004), such subsidiaries tend to lose influence within their group, and taken to the limit this may lead to the erosion of their independence (and their ability to acquire and then retain a competence-creating mandate). Thus it is reasonable to suppose that most strategically independent subsidiaries cooperate with other MNE units, and so utilize strategic independence as a means of leveraging local assets and embeddedness to enhance the competitive advantages of their MNE group as a whole (Andersson, Forsgren, and Holm, 2002).

Once a subsidiary has a competence-creating mandate, it is probable that strategic independence will cumulatively reinforce the mandate. Strategic independence provides such a subsidiary an increased ability to build its local competence, and tends to increase its creative contribution to the MNE (Birkinshaw et al., 1998). Thus, strategic independence leads to a higher level of R&D intensity. However, strategic independence in a subsidiary without a competence-creating mandate is unlikely to lead it to increase its R&D intensity, since its objectives are generally to exploit the existing competencies of the MNE. Increasing strategic independence may lead it instead to increase the level of other functions like local marketing.

Hypothesis 4a: A higher degree of subsidiary strategic independence increases the likelihood that the subsidiary achieves a competence-creating mandate.

Hypothesis 4b: An increasing degree of strategic independence increases the R&D intensity of subsidiaries with competence-creating mandates. Increasing strategic independence does not affect the R&D intensity of subsidiaries without competence-creating mandates.

MNE group-level determinants

The most notable group-level determinants of differences in R&D behavior in competence-creating as opposed to competence-exploiting subsidiaries may be with respect to the effect on local R&D intensity of whether a subsidiary was part of an acquired group. A number of studies have shown that a substantial proportion of internationalized R&D facilities in MNEs result from acquisition (e.g., Håkanson, 1981, 1995). When one group acquires another that has R&D facilities, some of the newly acquired facilities will tend to duplicate what is already done elsewhere in the acquiring
group. In this case, duplication may well be eliminated in the post-acquisition integration process, and subsidiaries that were part of the acquired group are likelier to suffer the brunt of any cutbacks.

Acquired subsidiaries that are conducting only standard competence-exploiting R&D tasks that are replicated in the acquiring group are in a more vulnerable position in this respect. The ability of subsidiary managers to exercise a voice within their new head office will tend to be weaker than those in established subsidiaries whose ties and identification with the parent group go back longer. The managers that were part of an acquired group tend to be associated with a different corporate culture (Sambharya, 1996). Thus, R&D intensity is likely to fall as duplication in the merged group is eliminated following the acquisition. Since there are still many more purely competence-exploiting subsidiaries than there are competence-creating, this is consistent with the finding of Hitt et al. (1991) that on average acquisitions tend to reduce R&D intensity. Since there are still many more purely competence-exploiting subsidiaries than there are competence-creating, this is consistent with the finding of Hitt et al. (1991) that on average acquisitions tend to reduce R&D intensity.

Hypothesis 5: Being part of an acquired group reduces R&D intensity for subsidiaries without competence-creating mandates, but increases it for subsidiaries with competence-creating mandates.

A further MNE group-level influence on the R&D of subsidiaries with competence-creating mandates, as opposed to those without, is the degree of product or business diversification required of the subsidiary. Hitt, Hoskisson, and Kim (1997) found that, although in general the degree of internationalization of the firm has a positive effect on R&D intensity, the interaction effects of internationalization with product diversification are negative. When they have competence-creating mandates, subsidiaries that are engaged in diversification away from the main lines of business activity of their MNE find themselves more tightly resource-constrained in the sense of Penrose (1959), which will tend to lower the extent of their local R&D. Subsidiaries with competence-creating mandates are all heavily committed to their creative tasks. Those that have to contend with a new line of business (LOB) must expend resources on other new functions associated with developing it and have fewer resources available for the R&D function. What is more, in running a new LOB it becomes more difficult for them to integrate their competence creation with the wider group of which they are part, so they are likelier to become isolated and to be seen as strategically marginal, and they get correspondingly less investment. In contrast, subsidiaries without competence-creating mandates have less responsibility and fewer binding resource constraints, and they may need more R&D for the purposes of new product adaptation of a kind that by definition is not carried out elsewhere in their group. For such subsidiaries, the impact of entering a new LOB is likely to have a smaller effect on R&D intensity.

Hypothesis 6: Operating outside of the parent MNE's main LOB leads to lower R&D intensity for subsidiaries with competence-creating mandates. Such diversification has no effect on the R&D intensity of subsidiaries without competence-creating mandates.

In addition, the proportion of subsidiaries that are able to earn a competence-creating mandate in any
MNE is regulated by the priority accorded to the technology sourcing motive in the group’s international investment strategy. This will depend on the nationality of ownership of the group, since groups originating from countries whose outward investment is mainly of more recent vintage (like Japan, as opposed to the United States) are likelier to assign a higher priority to technology sourcing in their investment strategies. This is partly because they are generally trying to draw on their international operations to help them to catch up with more mature MNEs from countries of origin of longer standing, and partly because, while long-established MNEs have evolved towards cross-border networks, newer MNEs may attempt to put in place networked structures from the outset. Distinguishing U.S.-owned and Japanese-owned subsidiaries in the United Kingdom from those that were European-owned is also useful when considering further the effects on R&D among subsidiaries that have acquired a competence-creating mandate. Subsidiaries that acquire a competence-creating mandate may be likelier to attract more R&D resources if the group of which they are part does not have its competence-creating headquarters located close by in another European country.

**Other controls**

Besides the above factors, we introduce a number of other control variables. Although the sample is restricted to a single industry (engineering and engineering-related activities) to make the R&D activities comparable across firms, we nonetheless control for intra-industry variation by introducing sub-industry dummies. We expect the quantitative level of R&D intensity to be sensitive to a number of other factors. Hence, in addition to the above, we control for differences in relative parent–subsidiary risk by introducing a relative home country/host country risk measure. Differences in R&D intensity can stem from differences in subsidiary performance relative to other subsidiaries. We attempt to capture this by introducing the difference between the subsidiary’s rate of return and the overall rate of return of the parent. Further, there may be duration effects over and above those captured in the strategic independence measure. We capture these by introducing the duration of the subsidiary’s operations in the host country. Finally, the extent to which the subsidiary is externally focused, e.g., focused on exports from the host country, may influence its R&D intensity. We control for this effect by introducing a measure of external focus.

**METHODOLOGY AND DATA**

**The estimating procedure**

Once a firm determines whether to locate technologically advanced (competence-creating) or assembly-based (competence-exploiting) production at a site, it must then decide the extent of R&D activity it will undertake at the host location. Our empirical measurement of whether or not a subsidiary has achieved a competence-creating mandate is closest to the output-based distinction of Cantwell (1987) in the typologies of Table 1. This is because we distinguished on a 5-point scale subsidiaries that reported the functional scope of their output mandate as being limited to sales and service, assembly, or manufacturing (a lack of any local competence-creating mandate) from those whose scope included either product development or international market development (the presence of a competence-creating mandate). The strategy choice presented here is that of a firm that has already decided on an internationally integrated strategy of competence development through technologically advanced production in selected foreign locations, and is next considering how wide a range of subsidiaries across which this function is to be implemented, and in which particular subsidiaries.

We set up this initial stage as a binary process under which the local subsidiary (with the support of the parent MNE) either achieves a competence-creating mandate \( (\text{subsidiary mandate} = 1) \) or not \( (\text{subsidiary mandate} = 0) \). If it does, the subsidiary’s development function in production will be of a higher grade, which necessitates a more exploratory type of local R&D facility. The decision regarding the level and kind of R&D to site locally is therefore conditioned on whether or not a competence-creating mandate has been achieved by the subsidiary. This conditional approach is fairly standard in the modal choice literature on FDI (Czinkota, Ronkainen, and Moffett, 1996; Devereux and Griffith, 1998; Grant, 1995; Mudambi and Ricketts, 1998).

The level of R&D expenditure (and hence the R&D/sales ratio) is also determined by locational,
subsidiary-level, and MNE group-level characteristics, with the binary subsidiary mandate variable providing an additive difference. Certain variables affecting the strategic outcome regarding the competence-creating mandate also affect the operational choice of level of R&D spending (see Hypotheses 1 and 4 above). Thus, some variables affect both the quality as well as the quantity of R&D undertaken by the subsidiary. We estimate the subsidiary mandate and its R&D intensity as simultaneously determined variables (see the Appendix for more details).

Data
R&D is a very industry-specific activity. The differences in strategies and R&D intensities between firms are highly industry-specific. These industry effects might wipe out any more subtle strategic choice effects in a diverse dataset. With this in mind, we restrict our focus to a single industry group, so that the strategies and expenditures are generally comparable. We focus on firms in engineering and engineering-related industries.

The current study uses three levels of data: industry-level data, location-specific data and subsidiary-level data. Industry-level data are used mainly for classification purposes and were drawn from Dun & Bradstreet indexes (Dun & Bradstreet, 1994, 1995). The engineering and engineering-related industry group roughly corresponds to subsections 24(1 & 2), 26–32 and 34–35 under the 1992 U.K. Standard Industrial Classification code (Office of National Statistics, 1992). Location-specific data relate to the classification of the local area in terms of Regional Selective Assistance (RSA) program and are based on the relevant Department of Trade and Industry (DTI) assisted areas map (August, 1993). Data comparing location risk characteristics of the host country (the United Kingdom) with those in the companies’ home countries were drawn from the financial markets publication Euromoney. The subsidiary-level data were derived from a large 1995 postal survey of foreign-owned firms in the United Kingdom, supported by telephone and field interviews. Table 3 includes definitions all the variables used in the estimation, along with the source of the data. Descriptive statistics related to all these variables are presented in Table 4(a).

The target population for this survey was constructed from Dun & Bradstreet indexes (Dun & Bradstreet, 1994, 1995), supplemented by the London Business School company annual report library. The target population yielded a preliminary list of 601 subsidiaries with personal contact names. Subsidiaries for which separate data for the parent firm were unavailable were deleted. The final usable population consisted of 568 subsidiaries. The survey was mailed out in two waves of 224 and 344 in March and April 1995.

The first (pilot) wave focused on entries into the Midlands region (the most successful region in the United Kingdom in terms of attracting FDI), while the second wave targeted entries into the rest of the country. In order to improve the response rate, the questionnaire had to be short, concise, and of current interest or salient to the respondent (Heberlein and Baumgartner, 1978). Two reminders were faxed to the companies that had not yet responded 10 and 21 days after the survey was mailed out.

Overall, 244 responses were received to the mail survey (42.96%). Of these, seven were found to be U.K.-owned firms mistakenly identified as non-U.K.-owned firms, and 12 were unusable for various other reasons, leaving 225 (39.61%) valid responses for evaluation. The response rate is well within the range expected for an unsolicited mail survey.

Non-response bias was investigated with the widely used method suggested by Armstrong and Overton (1977). This involved comparing early and late respondents. Two sets of late respondents were defined corresponding to those who responded after receiving the first reminder and those who responded after receiving the second faxed reminder (the first set includes the second). Each set of late respondents was compared to the early respondents on the basis of six sample measures. The comparisons were carried out using a $\chi^2$ test of independence. In both cases, the responses from early and late respondents were virtually identical.

Survey responses were tested for veracity by comparing postal responses to responses obtained from field interviews. A total of 28 field interviews were carried out. Using a $\chi^2$ test of independence, responses from field interviews were found to be virtually identical to those obtained from the postal survey on the basis of four sample measures. Finally, 20 respondents were randomly selected and interviewed by telephone to confirm their survey responses.
### Table 3. Variable definitions

<table>
<thead>
<tr>
<th>Variable</th>
<th>Definition</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Dependent variables</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Subsidiary mandate</td>
<td>1, the U.K. subsidiary has achieved a competence-creating mandate&lt;sup&gt;a&lt;/sup&gt; 0, otherwise</td>
<td>Survey, supplemented by company annual reports</td>
</tr>
<tr>
<td>R&amp;D intensity</td>
<td>U.K. subsidiary’s R&amp;D/sales ratio, 1994</td>
<td>Survey, supplemented by company annual reports</td>
</tr>
<tr>
<td><strong>Locational determinants of R&amp;D</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>RSA-1</td>
<td>1, if U.K. subsidiary is in a Development Area under the Regional Selective Assistance (RSA) Program&lt;sup&gt;b&lt;/sup&gt; 0, otherwise</td>
<td>Department of Trade and Industry (DTI)</td>
</tr>
<tr>
<td>RSA-2</td>
<td>1, if the U.K. subsidiary is in an Intermediate Area under the Regional Selective Assistance (RSA) Program&lt;sup&gt;b&lt;/sup&gt; 0, otherwise</td>
<td>Department of Trade and Industry (DTI)</td>
</tr>
<tr>
<td>Sales</td>
<td>U.K. subsidiary sales, 1994 (£million)</td>
<td>Survey, supplemented by company annual reports</td>
</tr>
<tr>
<td>Variability of demand</td>
<td>Variance of U.K. subsidiary’s rate of return on capital, 1986–94</td>
<td>Survey, supplemented by company annual reports</td>
</tr>
<tr>
<td><strong>Subsidiary-level determinants of R&amp;D</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Subsidiary strategic independence</td>
<td>First principal component factor score generated from the variables below. The following variables load on this factor: supplier decisions, hiring decisions, marketing decisions, and top management team</td>
<td></td>
</tr>
<tr>
<td>Supplier decisions</td>
<td>Extent to which decisions on suppliers are made in the U.K. (7-point Likert scale)</td>
<td>Survey</td>
</tr>
<tr>
<td>Hiring decisions</td>
<td>Extent to which U.K. subsidiary has responsibility for hiring management staff (7-point Likert scale)</td>
<td>Survey</td>
</tr>
<tr>
<td>Marketing decisions</td>
<td>Extent of responsibilities in the international marketing function (7-point Likert scale)</td>
<td>Survey</td>
</tr>
<tr>
<td>Top management team</td>
<td>Percentage of U.K. subsidiary top management (directors and above) from host country (U.K.)</td>
<td>Survey, supplemented by company annual reports</td>
</tr>
<tr>
<td>Export share</td>
<td>Exports as a percentage of U.K. subsidiary output</td>
<td>Survey, supplemented by company annual reports</td>
</tr>
<tr>
<td>Export duration</td>
<td>Years of exporting as a percentage of total duration of U.K. operations</td>
<td>Survey, supplemented by company annual reports</td>
</tr>
<tr>
<td>Geographic scope</td>
<td>Geographical scope of U.K. subsidiary’s output mandate: (1) U.K. only; (2) U.K. and mainland Europe; (3) worldwide</td>
<td>Survey, supplemented by company annual reports</td>
</tr>
<tr>
<td>Process decisions</td>
<td>U.K. subsidiary’s process engineering operational responsibilities (7-point Likert scale)</td>
<td>Survey</td>
</tr>
<tr>
<td>Training decisions</td>
<td>Extent to which U.K. subsidiary has responsibility for training in process engineering (7-point Likert scale)</td>
<td>Survey</td>
</tr>
</tbody>
</table>
MNE group-level determinants of R&D

**Acquired**
1, if U.K. operations are the result of an acquisition
0, otherwise

**Diversified**
0, if operations in the U.K. are in parent’s main line of business
1, otherwise

**U.S. parent**
1, if parent firm HQ is in the U.S.
0, otherwise

**Japanese parent**
1, if parent firm HQ is in Japan
0, otherwise

Control variables

**External focus**: Second principal component factor score generated from the subsidiary specific variables above. The following variables load on this factor:
- **export share**, **export duration**, and **geographic scope**
- **Abnormal ROR**: U.K. subsidiary’s rate of return (ROR) on capital less parent firm’s corporate ROR on capital, 1994
- **Duration**: Duration of U.K. subsidiary operations (years)
- **Electrical Group**: 1, if U.K. subsidiary is in an electrical engineering and related industry
0, otherwise
- **Mechanical Group**: 1, if U.K. subsidiary is in a mechanical engineering and related industry
0, otherwise
- **Chemical Group**: 1, if U.K. subsidiary is in a chemical engineering and related industry
0, otherwise
- **Location risk**: Relative country risk, home country/host country (U.K.); average, 1993–94

Subsidiary mandate is generated on the basis of the functional scope of the U.K. subsidiary’s output mandate. Output mandates were categorized as: (1) Sales and service; (2) Assembly; (3) Manufacturing; (4) Product development; (5) International strategy development. A competence-creating mandate is operationalized as a subsidiary whose output mandate is either (4) or (5).

*Subsidiary mandate* is generated on the basis of the functional scope of the U.K. subsidiary’s output mandate. Output mandates were categorized as: (1) Sales and service; (2) Assembly; (3) Manufacturing; (4) Product development; (5) International strategy development. A competence-creating mandate is operationalized as a subsidiary whose output mandate is either (4) or (5).

Department of Trade and Industry (DTI) Assisted Areas map (revised, August 1993).

The parent firm’s main line of business is defined to be its largest non-U.K. sales segments whose cumulative contribution to the entropy index of diversification just exceeds 60%. This definition is based on Hitt et al (1997).

* Euromoney risk index, which includes economic performance, political risk, debt indicators, debt default, credit ratings, access to bank, short-term and capital market finance, and the discount on forfaiting.

Survey, supplemented by DTI data
Survey, supplemented by company annual reports and DTI data
Survey, supplemented by company annual reports
Survey, supplemented by company annual reports
Survey, supplemented by company annual reports
Survey, supplemented by company annual reports
Survey, supplemented by company annual reports
Survey, supplemented by company annual reports
Survey, supplemented by company annual reports
Survey, supplemented by company annual reports
Survey, supplemented by company annual reports
Survey, supplemented by company annual reports
Survey, supplemented by company annual reports
Survey, supplemented by company annual reports
Survey, supplemented by company annual reports
Survey, supplemented by company annual reports
Survey, supplemented by company annual reports
Table 4(a). Summary statistics

<table>
<thead>
<tr>
<th>Variable</th>
<th>Mean</th>
<th>S.D.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Dependent variables</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Subsidiary mandate</td>
<td>0.2444</td>
<td>0.4307</td>
</tr>
<tr>
<td>R&amp;D intensity</td>
<td>4.1822</td>
<td>2.7963</td>
</tr>
<tr>
<td><strong>Locational determinants of R&amp;D</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>RSA-1</td>
<td>0.4089</td>
<td>0.4927</td>
</tr>
<tr>
<td>RSA-2</td>
<td>0.1200</td>
<td>0.3257</td>
</tr>
<tr>
<td>Sales</td>
<td>374.6445</td>
<td>327.7262</td>
</tr>
<tr>
<td>Variability of demand</td>
<td>3.6927</td>
<td>5.1599</td>
</tr>
<tr>
<td><strong>Subsidiary-level determinants of R&amp;D</strong></td>
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<td></td>
</tr>
<tr>
<td>Strategic independence</td>
<td>0.0063</td>
<td>1.0403</td>
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<tr>
<td><strong>MNE group-level determinants of R&amp;D</strong></td>
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<td></td>
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<tr>
<td>Acquired</td>
<td>0.6311</td>
<td>0.4836</td>
</tr>
<tr>
<td>Diversified</td>
<td>0.2089</td>
<td>0.4074</td>
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<tr>
<td>U.S. parent</td>
<td>0.2044</td>
<td>0.4042</td>
</tr>
<tr>
<td>Japanese parent</td>
<td>0.0711</td>
<td>0.2576</td>
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<tr>
<td><strong>Control variables</strong></td>
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<td></td>
</tr>
<tr>
<td>External focus</td>
<td>0.0280</td>
<td>0.9980</td>
</tr>
<tr>
<td>Abnormal ROR</td>
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<td>Duration</td>
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<td>Electrical group</td>
<td>0.4267</td>
<td>0.4957</td>
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<td>Mechanical group</td>
<td>0.4089</td>
<td>0.4709</td>
</tr>
<tr>
<td>Chemical group</td>
<td>0.1644</td>
<td>0.4307</td>
</tr>
<tr>
<td>Location risk</td>
<td>1.4808</td>
<td>1.0830</td>
</tr>
</tbody>
</table>

**ESTIMATION AND RESULTS**

**Estimating R&D strategy and intensity**

The simplest approach to comparing R&D intensity between competence-creating and competence-exploiting subsidiaries is presented using summary statistics in Table 4(b). The average level of \( R&D \) intensity is considerably higher for units with the subsidiary mandate = 1. The pattern of use of the competencies of the mandated subsidiaries appears here as well, with much higher levels of citations of their patents by other units within their corporate groups during the period 1995–2002. In contrast, the two types of subsidiary are much more similar in terms of the citations of their patents by other firms in the host location (the U.K.). This serves to demonstrate that the knowledge generation strategies of competence-creating subsidiaries are more closely integrated with the needs of their MNE group, and suggests that their R&D may indeed be not just higher on average, but also differently motivated.

As discussed above, the subsidiary competence-creating mandate is specified to be endogenous to the firm (including the subsidiary). We assume that the decision process is sequential, so that the competence-creating strategy is selected first, and the level of R&D-intensity is selected conditional on the mandating decision. With this assumption, R&D intensity may be estimated using a single-equation (or limited information) approach.

We estimate it using two alternative econometric models: a conventional instrumental variables (IV) model and a selection model using the Heckman procedure. Both models allow us to endogenize the subsidiary mandate choice variable.

The strategic decision model involved in granting a competence-creating mandate is estimated using binomial probit. Maximum likelihood estimates of this equation are reported in Table 5. Examining the estimates in Table 5, we find that the fit of the probit estimates to the data is very good, as measured by the likelihood ratio test. Location in a Development Area under the Regional Selective Assistance program (RSA-1) appears to exert a negative influence on the chance of achieving a competence-creating mandate. It would appear that the negative labor and infrastructural factors associated with a Development Area greatly reduce its probability of serving as a research-related hub for an MNE. Thus, we find evidence supporting Hypothesis 1a.

The subsidiary’s strategic independence also appears to significantly increase the probability of gaining a competence-creating mandate. Thus,

| Table 4(b). R&D measures for subsidiaries with subsidiary mandate = 0 and subsidiary mandate = 1 |
|----|----|----|----|
| **Subsidiary mandate = 0** | **Subsidiary mandate = 1** |
| **R&D intensity (%)**     | Mean    | S.D.    | Mean    | S.D.    |
|                           | 2.9118  | 2.5490  | 5.0182  | 2.9334  |
| Forward citations by other patents assigned within the parent MNE group: 1995–2002 | 1.6765  | 2.2735  | 3.0727  | 7.1666  |
| Forward citations by other patents assigned within the host location (U.K.): 1995–2002 | 2.4118  | 4.7768  | 2.8909  | 4.9488  |

*Source: U.S. Patent and Trademark Office.*
As outlined earlier, the home country dummy variables offer a means by which we can examine the effects on the likelihood of the emergence of competence-creating subsidiary mandates owing to the particular encouragement of the parent group. Thus, the greater observed likelihood of the acquisition of a competence-creating mandate in Japanese-owned subsidiaries may be attributable to the strategy of Japanese firms in the European Union as a whole and reflect their age as newer MNEs (than those that are U.S.-owned or European-owned), which have accorded a higher priority to technology sourcing in their international investment strategies and attempted to put in place a networked organizational structure from the start. This is in line with our earlier expectations, and Cantwell and Mudambi (2000) report similar results.

We now turn to our estimates of subsidiary R&D intensity. Both IV and selection model estimates are reported in Table 6. The selection model enables us to explicitly estimate the selection parameter, \( \lambda \). As the first stage estimates determining the probability of the strategy selection are probit estimates, the selection parameter is a hazard rate computed from the normal distribution. In the selection model, the direct effects of strategy selection (subsidiary mandate) are separated from the indirect effects (\( \lambda \)). While the IV model does not allow us to explicitly estimate the selection parameter, these linear estimates tend to be more robust than the non-linear Heckman selection estimates and serve as a useful robustness check. We will therefore focus on the results of the selection model.

When the selection model is applied to the entire sample (Table 6, column 3), the problem that arises is that the parameters of the regressors are restricted to be the same for subsidiaries that have competence-creating mandates (subsidiary mandate = 1) and those that do not (subsidiary mandate = 0). This restriction may well be questioned. Indeed, testing this restriction using a generalized ‘F’ test, we find that it is rejected. The way out is to estimate R&D intensity separately for subsidiaries that have competence-creating mandates (Table 6, column 5) and those that do not (Table 6, column 4). Greene (1993) suggests a procedure that may be used to generate such estimates and calls it the ‘treatment’ model. (See the Appendix for details; Shaver, 1998, makes similar use of the treatment model.)

The estimates of the treatment model are also presented in Table 6 and they provide us with the means of testing our remaining hypotheses. Locations in Development and Intermediate (RSA-1 and RSA-2) areas have a very negative influence on R&D for subsidiaries that have competence-creating mandates. Local development characteristics play little role if such a mandate is lacking. This demonstrates that supply-related development characteristics are critical to the success of competence-creating subsidiaries, as their greater

<table>
<thead>
<tr>
<th>Regressor</th>
<th>Parameter estimate ('t' stat)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Constant</td>
<td>-0.4152 (1.49)</td>
</tr>
<tr>
<td><strong>Locational determinants of mandate</strong></td>
<td></td>
</tr>
<tr>
<td>RSA-1</td>
<td>-0.5336 (2.53)*</td>
</tr>
<tr>
<td>RSA-2</td>
<td>-0.0780 (0.26)</td>
</tr>
<tr>
<td><strong>Subsidiary-level determinants of mandate</strong></td>
<td></td>
</tr>
<tr>
<td>Strategic</td>
<td>0.2235 (2.39)*</td>
</tr>
<tr>
<td>Japanese parent</td>
<td>0.6988 (2.06)*</td>
</tr>
<tr>
<td><strong>Control variables</strong></td>
<td></td>
</tr>
<tr>
<td>Electrical group</td>
<td>0.0007 (0.00)</td>
</tr>
<tr>
<td>Mechanical group</td>
<td>-0.0317 (0.12)</td>
</tr>
<tr>
<td><strong>Diagnostics</strong></td>
<td></td>
</tr>
<tr>
<td>Log-likelihood</td>
<td>-114.9804</td>
</tr>
<tr>
<td>Restricted</td>
<td>-125.1335</td>
</tr>
<tr>
<td>log-likelihood</td>
<td>20.3063</td>
</tr>
<tr>
<td>Likelihood ratio</td>
<td></td>
</tr>
<tr>
<td>test: ( \chi^2(9) )</td>
<td>0.0161</td>
</tr>
<tr>
<td>p-value</td>
<td>0.161</td>
</tr>
<tr>
<td>Iterations</td>
<td>5</td>
</tr>
</tbody>
</table>

* -statistics in parentheses
Estimate significant at the * 5% level; ** 1% level
degree of research creativity requires a satisfactory educational and skill base locally, and the presence of other innovative enterprises with which to interact. This provides support for Hypothesis 1b.

It illustrates as well how Table 6 shows that the R&D behavior of subsidiaries with competence-creating mandates is not just quantitatively but also qualitatively different from that of other subsidiaries, in that the determinants of R&D intensity differ. Conversely, the positive influence of Sales, and the negative effect of Variability of demand for all firms considered together are seen to emanate from subsidiaries that do not have a competence-creating mandate. They do not appear to influence R&D intensity for subsidiaries that have a mandate. For competence-creating subsidiaries the size or scale of local production and the variability of local demand matters less. We find support for both Hypotheses 2 and 3.

For all subsidiaries taken together, the degree of strategic independence of the subsidiary cannot be separately distinguished from the effect of the competence-creating mandate. However, once subsidiaries with or without the mandate are divided,
Strategic independence has a significant effect on R&D within the mandated group, but not for other subsidiaries. This might be thought of as a kind of cumulative effect. That is, once a subsidiary has achieved a competence-creating mandate, its capacity to fulfill that mandate will be strengthened by the extent to which the subsidiary is able to develop its own independent strategy, which will facilitate its own greater local creativity and warrant increased local R&D. Yet crucially this effect of subsidiary strategic independence is absent if the subsidiary itself is not mandated to be a constituent part of an internationally integrated network within its corporate group. Therefore the estimates provide support for Hypothesis 4b.

The negative influence of Acquired appears for subsidiaries that do not have a competence-creating mandate, in rather striking contrast to the positive influence of Acquired (which is significant at the 10% level) for subsidiaries that do. This is a very important result in the light of other recent research in the area of corporate mergers and acquisitions, and in view of the significance of acquisition for the overall internationalization of R&D. Cross-border acquisitions may, broadly speaking, be divided into those motivated mainly by financial considerations and those that are motivated by new asset acquisition and a synergy of complementary productive resources. Hence, as suggested by Table 6, in competence-creating subsidiaries the latter motives tend to dominate, subsidiary managers are able to use the distinctive contribution that their unit brings to the acquiring group to gain influence at their new head office, and acquired subsidiaries attract more research investment on average than do directly established subsidiaries. However, in the absence of such a mandate the tendency is for acquired subsidiaries to be obliged to eliminate R&D duplication since in this case the managers of an acquired subsidiary tend to have less influence at the head office than their counterparts in subsidiaries that were part of the acquiring group, and so acquired subsidiaries tend to become more reliant on R&D done elsewhere in the group to exploit their existing assets. The estimates of Table 6 therefore provide evidence in support of Hypothesis 5.

A similar but less striking contrast between R&D determinants in subsidiaries with or without competence-creating output mandates is observed in the significance of the negative impact of Diversified only in the competence-creating case. This is consistent with other evidence that has suggested that whereas at one time product diversification and technological diversification were complementary (or more precisely, they were different representations or ways of measuring of the same phenomenon), in more recent times they may be substitutes as a wider range of technologies is now needed to support a narrower range of products (Cantwell and Piscitello, 2000). This is indeed what our findings here suggest: that with a competence-creating mandate, a higher extent of product diversification tends to be a hindrance to investing in the creation of new technologies. It is not just that product diversification may now withdraw resources away from competence creation directly, but also that it makes it more difficult to integrate that competence creation with the needs of the wider group. In consequence subsidiary managers may lose influence within their group, and so attract less investment. However, this effect does not apply to the same extent to subsidiaries without this competence-creating function, for which the overwhelming goal in research is to adapt products (whether they are distinctive to that subsidiary or not) to the relevant markets. So our findings are supportive of Hypothesis 6.

There is one other especially notable difference in the two sets of estimates of Table 6, which (as with the MNE group-level effects on the mandate decision in Table 5) relates to influences that are captured through the use of home country dummy variables. Both Japanese and U.S. parentage seem to increase R&D intensity for subsidiaries with a mandate, but not for subsidiaries without one. While Japanese- and U.S.-owned MNEs have a smaller share of internationalized subsidiary R&D than European-owned MNEs, they are more likely to develop cross-border networks for innovation within Europe, since they do not have a home base on which to focus attention within the European area. Thus, when Japanese- and U.S.-owned subsidiaries gain competence-creating mandates, they tend to have greater opportunities for becoming sources of new knowledge within their respective European corporate groups.

Finally, following Shaver (1998), we ask: if subsidiaries in each category behaved like subsidiaries in the other, what would be their chosen R&D intensity? We address this question by computing the average R&D intensity for subsidiaries with competence-creating mandates using their average characteristics and their estimated coefficients.
Table 7. Estimated average R&D intensity
Subsidiaries with and without competence-creating mandates

<table>
<thead>
<tr>
<th>Percent Characteristics: average values</th>
<th>Subsidiary mandate = 0</th>
<th>Subsidiary mandate = 1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Estimated coefficients</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Subsidiary mandate = 0</td>
<td>3.182</td>
<td>−4.093</td>
</tr>
<tr>
<td>Subsidiary mandate = 1</td>
<td>−9.693</td>
<td>5.338</td>
</tr>
</tbody>
</table>

from Table 6. Then we pair the average characteristics of subsidiaries with mandates with the estimated coefficients for subsidiaries without mandates. We do the same, in reverse, for subsidiaries without mandates. These results are reported in Table 7. When subsidiaries behave to type, the estimated R&D intensity is a good fit to actual category average (compare the estimates on the diagonal in Table 7 with those reported in Table 4b). However, if mandated subsidiaries behaved like non-mandated subsidiaries, their estimated R&D intensity would become negative. The same occurs if non-mandated subsidiaries behaved like mandated subsidiaries. Clearly there is a qualitative difference in the way in which the two sets of subsidiaries conduct R&D.

What this demonstrates is that if non-mandated subsidiaries were to be asked to fulfill a competence-creating role, they would be unable to do so, and hence their R&D would tend to fall towards zero (the estimated R&D intensity appears to be negative). Conversely, if mandated subsidiaries behaved like non-mandated subsidiaries, their estimated R&D intensity would become negative. The same occurs if non-mandated subsidiaries behaved like mandated subsidiaries. Clearly there is a qualitative difference in the way in which the two sets of subsidiaries conduct R&D.

What this demonstrates is that if non-mandated subsidiaries were to be asked to fulfill a competence-creating role, they would be unable to do so, and hence their R&D would tend to fall towards zero (the estimated R&D intensity appears to be negative). Conversely, if mandated subsidiaries behaved like non-mandated subsidiaries, their estimated R&D intensity would become negative. The same occurs if non-mandated subsidiaries behaved like mandated subsidiaries. Clearly there is a qualitative difference in the way in which the two sets of subsidiaries conduct R&D.

We recognize that the patterns of global technology strategy in multinational firms have evolved over the decade since we collected our data. There has been an increasing trend toward moving R&D on the basis of cost and not just capabilities to emerging market economies with highly skilled workforces. The recent location of many R&D establishments in Eastern Europe and South Asia fit this description. One weakness of our single-country focus is the inability to capture such global trends.

However, we argue that the current global R&D strategy of MNEs is characterized by the twin drivers of capabilities and cost. As MNEs implement such a strategy we should observe an increasing diversity in the R&D activities as some subsidiaries focus on cost and move toward competence exploitation, while others focus on capability development and move toward competence creation. From this perspective the age of our data provides us with a historical perspective, indicating that current R&D strategies in MNEs are the product of an evolutionary process that has been going on for a decade, if not longer. The suggestive results we present for the 1995–2002 period (Table 4b) support such an interpretation.

CONCLUDING REMARKS

Our findings are consistent with other studies that have pointed to the emergence of global networks for innovation within MNEs in recent years. In this literature, it has been proposed that a subsidiary can contribute more creatively to technology generation within such a network, the better is the local infrastructure in the location in which it is sited, which increases its potential skill base and local linkages with other innovative firms and research institutions; the wider is the functional scope of its mandate, which broadens its potential role within the MNE network; and the more mature it is, having had time to evolve away from a principally domestic orientation and towards more closely internationally integrated relationships.

We suggest that the decision regarding the achievement of a competence-creating mandate to an MNE subsidiary is an endogenous one. Thus, subsidiaries obtain or do not obtain such mandates depending upon subsidiary-, group-, and location-specific factors. We find that treating the mandating decision as endogenous rather than exogenous gives us a clearer picture of MNE R&D investment behavior. We show that the R&D investments of subsidiaries with competence-creating mandates
are both qualitatively as well as quantitatively different from that of subsidiaries without such mandates.

In particular, supply-related local development potential and the degree to which subsidiaries are separately granted strategic independence both positively influence R&D in competence-creating subsidiaries, but not in other kinds of subsidiary. There is also a trade-off between technology-creating investments and product diversification in subsidiaries with competence-creating mandates, but not in other subsidiaries. However, while having been part of an acquired group positively affects R&D in subsidiaries with mandates, there is a negative impact of acquisition on local R&D in subsidiaries without mandates. This is an original finding, and one that carries very important implications in view of the sizeable proportion of foreign-located R&D that is the outcome of mergers and acquisitions. Likewise, there is no effect on R&D in mandated subsidiaries from the extent and variability of local demand, which clearly influence R&D in non-mandated subsidiaries since they conduct R&D primarily to adapt established products to local markets. These findings are very much in line with our expectations, but we believe they are novel results from our appropriate modeling of MNE R&D strategy decisions. The purposes and nature of R&D in non-mandated subsidiaries since they conduct R&D primarily to adapt established products to local markets. These findings are very much in line with our expectations, but we believe they are novel results from our appropriate modeling of MNE R&D strategy decisions. The purposes and nature of R&D in non-mandated subsidiaries since they conduct R&D primarily to adapt established products to local markets.

In terms of the theoretical implications of the approach we have taken and our findings, we return to our earlier observation that the previous literature on the typology of subsidiary R&D has made the divergence of subsidiary roles (competence-creating vs. competence-exploiting) largely a function of the location in which the subsidiary is sited. Certainly, we find here further strong support for the influence of location on subsidiary mandates, as well as on the determination of R&D in each type of subsidiary. Yet it turns out that the Marchian distinction between competence-creating subsidiaries' focus on exploration, in contrast to the focus of competence-exploiting subsidiaries, has its starkest divergence of impact on R&D in the context of subsidiary acquisition. Following acquisition, R&D rises in competence-creating subsidiaries, but it falls in competence-exploiting subsidiaries.

Thus, the subsidiary typology matters most of all for the amount of localized R&D not with respect to locational characteristics (which earlier researchers have emphasized), but rather with respect to firm-specific MNE group-level acquisition strategies. This underscores the theoretical need to allow for the interaction between firm-specific corporate strategy and location-specific factors when examining the divergent determinants of subsidiary-level R&D. What is more, MNEs that grow through acquisition may have more intra-subsidary diversity in the nature and level of localized R&D than those that rely on internal growth. As argued in our opening remarks, such intra-organizational diversity may well help to promote a better balance between exploration and exploitation in the technological learning of MNEs, but of course this potential benefit needs to be set against the costs of integrating and managing a more complex international network. While others have argued that acquisition strategies have particular advantages for laggard firms rather than leaders as a means of catching up by acquiring access to new capabilities in the context of specific host markets (e.g., Hennart and Park, 1993), our finding suggests that acquisitions may be useful for leader firms too in the wider context of the promotion of effective learning across international networks.

Our data show (from an historical vantage-point) that the bifurcation of subsidiary types we describe had already led to statistically significant differences in their paths by the early 1990s. Further research into these differences in subsidiary behavior would be welcome, but if subsidiary evolution has continued along alternative trajectories since that time then we might see a consolidation of this typological divide between subsidiaries.

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**APPENDIX: COMPETENCE-CREATING MANDATES AND SELECTION BIAS**

We are interested in the achievement of competence-creating mandates by subsidiaries. Subsidiaries obtain a mandate when the expected profitability of such a strategy is greater than that associated with a purely competence-exploiting strategy. This variable, which is defined as MAND∗, relates to the i-th subsidiary and is driven by its resources and capabilities. These resources, capabilities, and environmental factors may be gathered together in a vector Z, so that

\[ \text{MAND}_i^* = \mu'Z_i + \epsilon_i \]  

MAND∗, however, is a latent variable. The observed variable is the subsidiary mandate. It is denoted in this Appendix by MAND, where

\[ \text{MAND}_i = 1 \text{ MAND}_i^* > 0(\text{competence–creating mandate obtained}) \]  

\[ \text{MAND}_i = 0 \text{ MAND}_i^* \leq 0(\text{competence–exploiting strategy undertaken}) \]
the subsidiary) and is therefore an endogenous variable.

The decision regarding R&D expenditure (and hence the R&D/sales ratio denoted by RD) is also determined by subsidiary, group, and location characteristics, with the binary MAND variable providing an additive difference. The variables that affect R&D spending can be gathered together in a vector \( X \), which may share several variables with \( Z \). The estimation of RD may be specified as

\[
RD_i = \beta'X_i + \theta MAND_i + u_i \quad (3)
\]

Treating MAND as a normal exogenous variable in estimating the level of R&D intensity (RD) ignores its endogeneity—the common variables in \( X \) and \( Z \) mean that \( e_i \) and \( u_i \) are correlated. In other words, there is ‘selectivity’ correlation between MAND and RD, which may be defined as \( \rho \). The direct estimation of Equation 3 generates selectivity bias (Heckman, 1979). The effects of selection bias appear in both the mean and the variance of the estimator of \( \theta \) in Equation 3. The estimate of \( \theta \) is biased in the direction of the correlation between the errors \( u_i \) and \( e_i \). The estimated standard error of \( \theta \) is biased downwards, so the probability that it will appear significant is increased. For a more technical treatment of the problem of selection bias, see Greene (1993).

Assuming that the joint distribution of MAND and RD is bivariate normal, we have what is called a ‘selection’ model. Defining the vector of location and firm factors affecting RD as \( X \) and the standard normal distribution and density functions as \( \Phi(.) \) and \( \phi(.) \), we have

\[
E[RD_i | MAND = 1] = \beta'X_i + \theta + \rho \sigma_u \lambda
\]

\[
E[RD_i | MAND = 0] = \beta'X_i + \rho \sigma_u [\frac{\phi(\mu'Z_i)}{\Phi(\mu'Z_i)}]
\]

where \( \lambda \) is the selection parameter, i.e., the adjustment for the effects of incidental truncation.

There are two problems with the standard selection model in the context of MNE mandating decisions. (a) The estimated parameter vector, \( \beta' \), is restricted to be the same for both competence-creating and competence-exploiting strategies. (b) The coefficient on the selection parameter, \( \beta_\lambda \), is difficult to interpret, since it is also restricted to be the same for both strategies.

One way around this is to estimate the R&D intensity equation separately for subsidiaries with competence-creating mandates and those without, while accounting for the incidental truncation created by the selection. Thus, \( \lambda \) is estimated from the strategy decision Equation 1 as

\[
\lambda_i (MAND = 1) = \frac{\phi(\mu'Z_i)}{\Phi(\mu'Z_i)}
\]

\[
\lambda_i (MAND = 0) = -\frac{\phi(\mu'Z_i)}{[1 - \Phi(\mu'Z_i)]}
\]

Equation 4 can then be estimated separately for subsidiaries with and without competence-creating mandates. Explicitly, this amounts to estimating the following equations:

\[
E[RD_i | MAND = 1] = \beta'X_i + \theta + E[u_i | MAND = 1] \quad (6a)
\]

\[
= \beta'X_i + \theta + \rho \sigma_u \lambda
\]

\[
= \beta'X_i + \theta + \rho \sigma_u (\mu'Z_i | MAND = 1)
\]

\[
= \beta'X_i + \theta + \rho \sigma_u [\phi(\mu'Z_i)/\Phi(\mu'Z_i)]
\]

and

\[
E[RD_i | MAND = 0] = \beta'X_i + E[u_i | MAND = 0] \quad (6b)
\]

\[
= \beta'X_i + \rho \sigma_u \lambda
\]

\[
= \beta'X_i + \rho \sigma_u (-\phi(\mu'Z_i)/[1 - \Phi(\mu'Z_i)])
\]

While these estimates are not efficient, they are consistent and therefore improve as the sample size is increased.